REPORT 3
FEASIBLE OPTIONS STUDY – CENTRAL ARLINGTON HEIGHTS

1.0 INTRODUCTION

This report summarizes a study of feasible options to address chronic flooding in the watershed known as the Central Arlington Heights watershed. This flooding problem has posed challenges to the City of Fort Worth, as all previous solutions identified were extremely expensive and beyond the reasonable funding capacity of the city's storm water utility. The previous solutions were based on application of traditional engineering approaches to a specified design criteria, and the Feasible Options study seeks to identify additional measures using more innovative and alternative approaches that do not necessarily recognize a specific criteria.

The fundamental purpose of the study is to identify options to the previous recommendations for further consideration by the engineering team engaged by the city for the Central Arlington Heights watershed (Freese & Nichols). It is based upon a strong engagement with the project stakeholders and general public, along with a high level analysis of potential measures and analyses. This approach allows for a swifter identification and public vetting of potential measures without getting mired in a time consuming and expensive modeling exercise. Once recommendations are made, Freese and Nichols will provide more detailed analysis as directed by the city, while the city can begin implementation of more straightforward solutions. This approach was chosen by the city in order to attempt to expedite solutions while performing the necessary study and analyses.

This summary report presents the findings along with a brief description of the problem and the study process leading to the recommendations. A more detailed report has been prepared that provides documentation of the analyses supporting the conclusions.

Based upon the study of flooding in the Central Arlington Heights watershed, the following alternatives are recommended for near-term implementation:

- Install underground detention modules in Western Avenue right-of-way in conjunction with scheduled street re-construction project.
- Install underground detention modules in Ashland Avenue right-of-way in conjunction with scheduled water and sewer project.Acquire available properties near Hulen Street and Bryce Avenue and install interim detention storage.
- Acquire flood prone residences on a voluntary basis, and develop and implement secondary use plan.

In addition, the following alternative are recommended for implementation as schedules and coordination with others facilitates:

- Acquire land and construct surface detention basins near Bryce Avenue and Hulen Street.
- Install underground detention modules in city rights-of-way in conjunction with street re-construction projects.
- Install underground detention at Stripling Middle School and South Hi Mount Elementary schools.

Lastly, the following alternative requires additional feasibility analysis, and should be implemented if determined to be feasible and as funding allows (could be a considerable time, depending on cost):

- Divert Flow to FWISD Detention Sites

This report contains a summary of the planning study used to identify these options, and contains more detail regarding the specific recommendations.

2.0 BACKGROUND

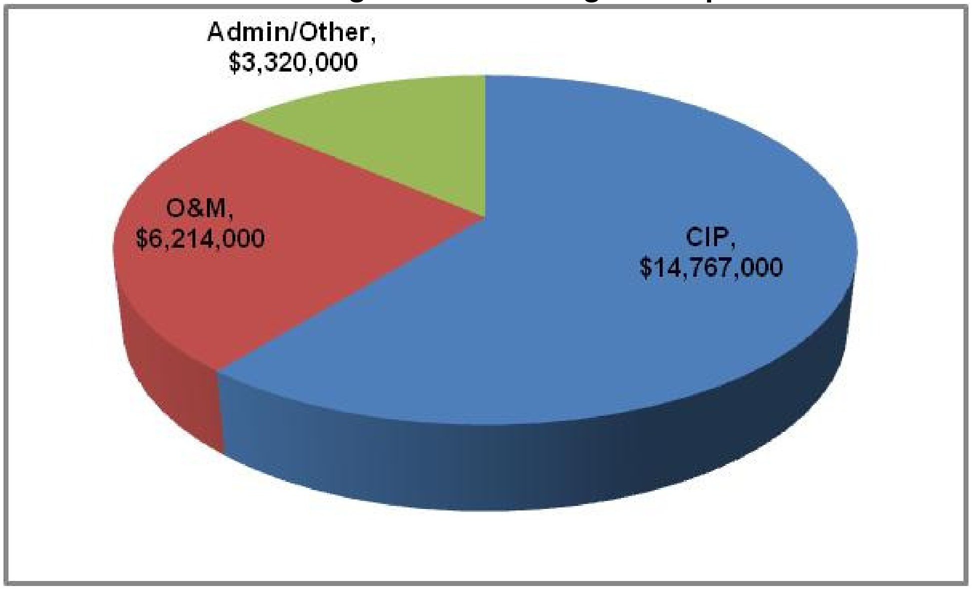
Residents of portions of the Arlington Heights neighborhood have long complained of frequent flooding from thunderstorms and rainfall events. After a rainfall event on June 28, 2004, a resident captured a dramatic video of flooding along Carleton Ave. This video showed a high volume of excess runoff entering the street from the backyards of homes, and showed substantial depth of flooding in the street.

This video, along with other incidences of flooding in that same year, was a large factor in the city establishing a Storm Water Utility Fee, in 2006, to fund improvements and maintenance of the drainage system. Prior to this, the city had minimal resources to address urban flooding, as the stormwater program received only about $5 million annually – barely enough to conduct minimal maintenance to meet federal standards.

To finance the new program, the City of Fort Worth began to issue bonds to finance maintenance and capital improvements, and these bonds are retired from revenue raised from the utility fee. In 2007, the city sold $25 million in bonds to fund the program for two years. These funds were used to repair a dangerous crossing where lives were lost, to conduct inventory of the existing systems, to begin planning studies for the Capital Improvement Program (CIP), and to increase maintenance activity on the existing infrastructure. In 2009, the city sold $45 million in bonds to continue these activities and begin implementation of projects to address urban flooding. These funds were intended to support the program for two years – 2009 and 2010.

Figure 1 shows a breakdown of the budgeted expenditures for 2011. The pie chart indicates that, based upon existing storm water utility rates, approximately $15 million is available annually for upgrades and improvements to the existing infrastructure.

Figure 1
Storm Water Program – 2011 Budgeted Expenditures



The flooding in 2004 and years surrounding was particularly noteworthy in two areas – the Central Arlington Heights watershed and the Forest Park-Berry watershed. Residents and business leaders in these communities were instrumental in establishing the utility, and due to the severity of flooding, addressing flooding in these areas was made a priority. Freese and Nichols was engaged to evaluate the Central Arlington Heights watershed and to identify and recommend measures to address the flooding.

The Freese and Nichols study identified a number of alternative plans to address flooding. The initial study identified four plans, with the total cost ranging between $20.4 million and $48.9 million. As directed by the city, and in accordance with city criteria, Freese and Nichols only considered plans that would reduce flooding for events up to and including the flood event expected to occur once every 100 years (also known as the “100-year event”).

Considering that, at current rates, the storm water utility only allows for $15 million annually in capital improvements for the entire city, the city had concerns regarding the cost of the identified solutions. Furthermore, the lowest cost solution involved substantial open cut of streets that may impede mobility and access to homes, and may not be implementable because of those concerns.

In response to concerns, the Sunland Group was engaged to lead a Value Engineering exercise with the consultant team and city staff. This activity involved refinement of the existing alternatives, including their cost estimates, and the consideration of additional alternatives. The Value Engineering study resulted in seven alternative plans, with costs ranging between $27.8 million and $60.0 million. In addition, the lowest cost alternatives use the existing system outfall upstream of the Union Pacific Rail Yard. These plans would most certainly include additional costs to address concerns related to potential flooding impacts in the rail yard.

At the conclusion of the Value Engineering study, no feasible plan had been identified to address flooding in the Central Arlington Heights watershed. Similar challenges were found in identifying solutions to flooding in the Forest Park-Berry watershed, and looking beyond the city noted that it is likely that economic challenges will impede implementation of solutions to urban flooding in many neighborhoods. The city has estimated that the cost to address flooding across the entire city is approximately **$1.2 billion**, and of this approximately **$350 million** is considered critical.

In response to these concerns, Michael Baker, Jr., Inc., was engaged to identify feasible options to solutions to flooding in the Central Arlington Heights and Forest Park-Berry watersheds. While this study is focused on these two watersheds, the results and lessons learned are to be framed in a manner to apply citywide in addressing the economic challenges related to the solving flooding in Fort Worth. This study is not a detailed engineering study. Instead, it is focused on the identification and screening of alternatives approaches, including alternatives from the traditional engineering solutions. Further analysis of the options identified will be considered by the City of Fort Worth and their consultant team.

As it pertains to the Central Arlington Heights watershed, the Feasible Options Study seeks to provide answers to the following questions:

- Are there other, more affordable, options that should be considered to address chronic flooding in the Central Arlington Heights watershed?
- Are there other options that would bring relief to chronic flooding in a more timely manner?

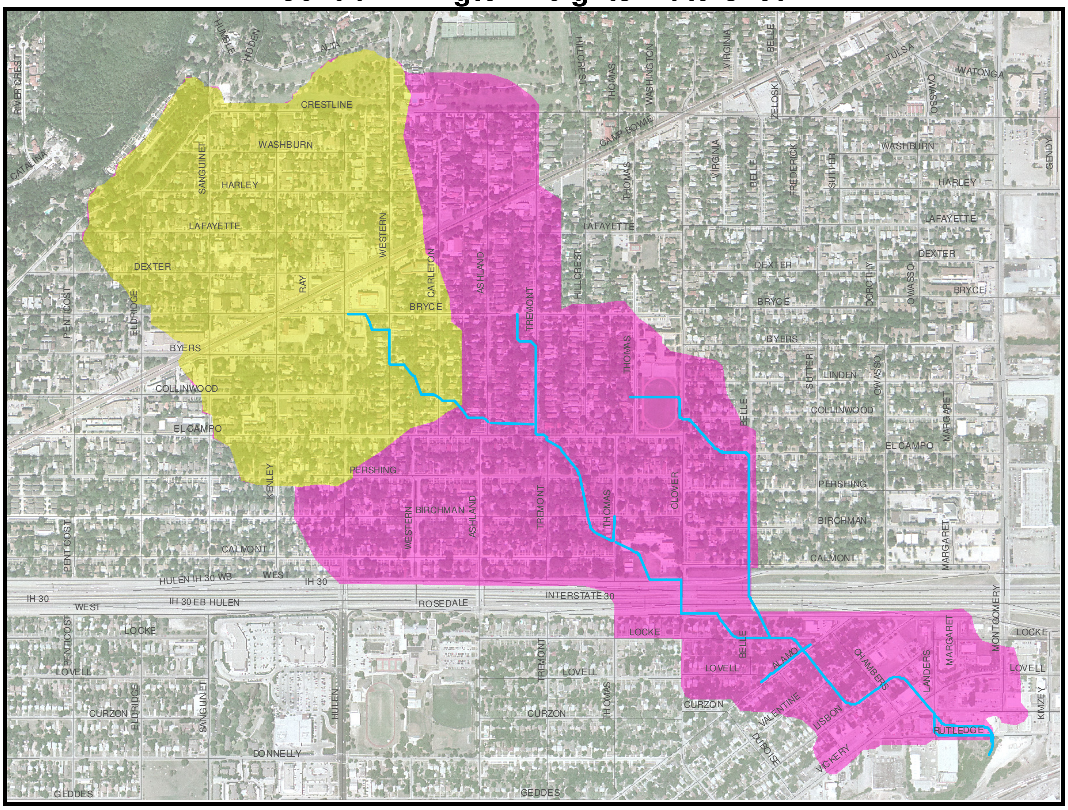
3.0 THE CENTRAL ARLINGTON HEIGHTS WATERSHED

The Central Arlington Heights watershed is defined as the area that drains to the main storm sewer trunkline that runs from near the intersection of Hulen St. and Bryce Ave. down to the Union Pacific Rail Yard just south of West Vickery Boulevard. The watershed consists of 454 acres, and is depicted in Figure 2 (both the gold and violet colored shading). The watershed includes much of the Arlington Heights community, and also includes portions of Alamo Heights and Crestline. The entire watershed is developed, consisting of mostly residential homes with some concentrated commercial areas. The watershed is bisected by IH-30. The main trunkline storm sewer outfalls to a small ditch just north of the Union Pacific Rail Yard. There is not adequate drainage capacity in the rail yard, and the flows mostly disperse overland through the railyard to the Clear Fork of the Trinity River.

Historically, the watershed was drained by small ravine that conveyed runoff to the Clear Fork. Development activity in the area began to occur in the late 1800's, with the vast majority occurring immediately in the early 1900's immediately after World War I. Prior to development, the natural ravine and swales were capable of carrying flow from ordinary rainfall events. During larger events, the flows would exceed the banks of the ravine and the runoff was stored and conveyed in the natural floodplains adjacent to the channel.

When developed, the land developers and the City of Fort Worth desired to reclaim as much developable area as possible. Instead of avoiding the ravines and its adjacent floodplains, the engineers designed pipes to replace natural system. The natural floodplain was then filled, and roads, homes, and businesses were constructed on top of these underground conveyance system. It appears the pipes were sized to convey a flowrate similar the capacity of the natural ravines – in other words they were sized to carry the ordinary storm event, with little or no provision for the larger storm event.

Figure 2
Central Arlington Heights Watershed

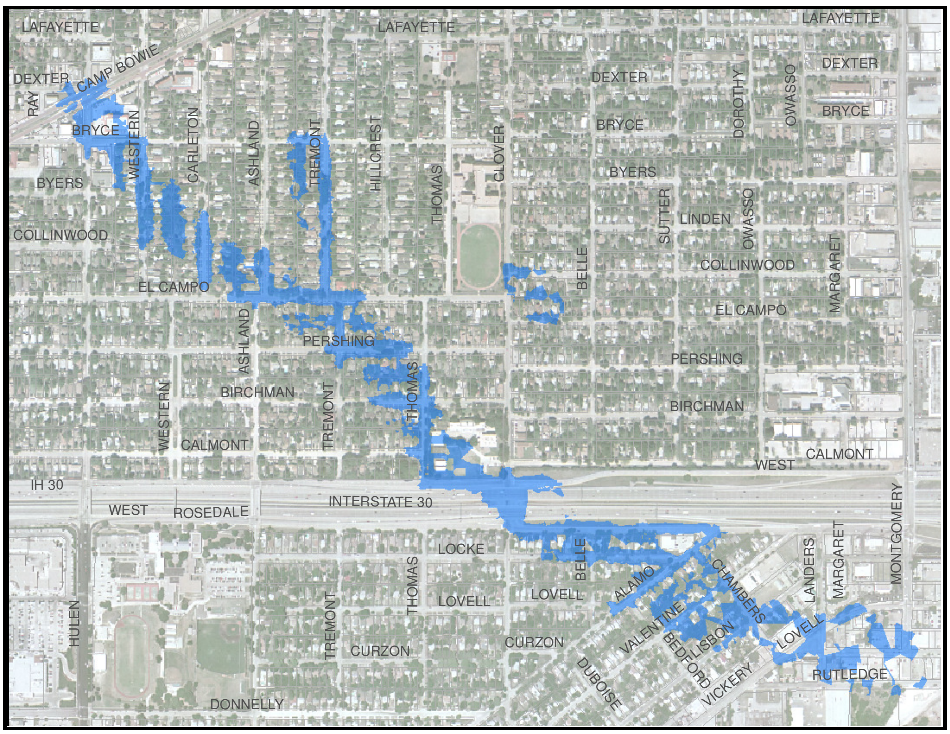


Consequently, today the excess flow is conveyed overland, in streets, alleys, and through lots and structures. Flood flows collect in low areas, filling them up until flows spill over, cascading to the next adjacent low area. This storage results in pseudo-detention, decreasing the pressure on the downstream pipe system while inundating portions of the watershed. During such events, homes flood, cars flood, properties are damaged, and streets are impassable. Figure 3 shows photographs taken in the watershed during past flood events. Figure 4 shows the estimated area inundated by an event expected to occur, on average, once every ten years.

This problem has existed since the development of the area. Over the years, the problem might have been exhausted to some small degree by the intensification of development. However, the current pipes are way too small for the contributing drainage area, and would be substantially larger if today's drainage criteria were to have been applied when the area was constructed.

Figure 3
Central Arlington Heights Flooding

Figure 4
Estimated Inundation from a 10-Year Event



4.0 PUBLIC ENGAGEMENT

The Feasible Options Study involved a robust and targeted public engagement process. This is critical to the study, as it is much more difficult to gauge a plan's level of acceptability than it is to evaluate its effectiveness or its affordability. The public engagement process was led by Pam Roach Public Relations and the City of Fort Worth's Community Relations Department.

A stakeholder committee was developed from a cross section of residents and stakeholders to assist in the public process. A number of public meetings and stakeholder meetings were held. Specifically, meetings were held on the following dates:

- October 22, 2010 – Public Meeting

- October 27, 2010 – Stakeholder Committee Meeting
- December 9, 2010 – Stakeholder Committee Meeting
- February 24, 2011 – Stakeholder Committee Meeting
- March 3, 2011 – Public Meeting

In addition, the project team and city staff read the book entitled *Fort Worth's Arlington Heights,* by Juliet George. In addition, Ms. George led the project team and city staff on a tour of the Arlington Heights neighborhood.

The project team supported the Arlington Heights Neighborhood Association in canvassing portions of the neighborhood, and the data sheets obtained in that activity were obtained by the project team.

The city also maintained a project website to disseminate information regarding the planning study. The website also contained a link to a survey for residents to complete, assisting the project team in capturing the sentiments in the community.

Lastly, attendees at the March 3, 2011 public meeting were given the opportunity to anonymously weigh in on issues via electronic audience polling devices.

5.0 PLANNING APPROACH

The Feasible Options Study was conducted by applying an organized and deliberate planning process that included the following elements:

- Understanding of existing condition
- Identification of goals, objectives, and constraints
- Identification and screening of measures
- Formulation and analysis of alternative plans
- Recommendations

5.1 Understanding of existing condition. Data collection and problem understanding had been completed by the city and by Freese and Nichols in their study, and that information was obtained from them. The preceding section of this report presents a description of the problem – which essentially can be stated that the capacity of the current drainage infrastructure is deficient, resulting in chronic flooding as streets, lots, and homes essentially provide storage of excess runoff.

According to the Freese and Nichols report, 58 properties are subject to damages during a 100-year event. The total appraised value of these properties if $8.7 million. Over a long period of time, flood damages in the Central Arlington Heights watershed are estimated to average just under $1 million per year, resulting in a present day estimated cost of flooding of about $13 million.

5.2 Objectives and Constraints

The planning team identified the following objectives of plans to reduce flooding in the Central Arlington Heights watershed:

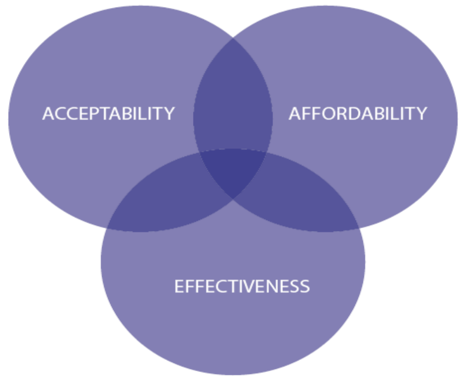
- *Reduce damages to homes, businesses, and property from urban flooding*. Areas within the Central Arlington Heights watershed are subject to chronic flooding, which causes monetary damage to property. The primary objective is to identify and implement measures to reduce these damages. PROVIDE MORE DETAIL REGARDING FLOOD DAMAGES
- *Enhance the overall community.* Flood damage reduction projects often present opportunities to implement projects in a manner that provide improvements and/or amenities to neighborhoods and communities. It is an objective of the project to identify such opportunities and incorporate them into plans such that the result of a project implementation is a net improvement in the quality of life of the community.
- *Improve the quality of storm water runoff where possible.* One aspect of the city's Stormwater Utility is to meet federal standards related to the quality of storm water runoff. Certain flood damage reduction components also work to address the quality of runoff; and in addition, the implantation of flood damage reduction features often affords the opportunity to implement water quality features. Where possible, such opportunities will be identified and requisite features will be recommended.
- *Phasablity.* Many large plans take years to implement, and often must be phased in over multiple projects. For purposes of this study, phasability refers <u>not</u> to the ability to construct the project in phases; rather, it refers to the ability to obtain incremental benefits of the project at the completion of each phase. As such, phasable projects will deliver relief much sooner.

In addition, the planning team identified the following constraints to the planning process:

- *Plans must be generally acceptable by a consensus of stakeholders.* Stakeholders are those who have an invested stake in the projects, and include flood victims, residents of the community, business owners in the community, and rate payers throughout the city, and others. The order presented above does represent some element of priority in voice, as those directly impacted by flooding have a larger stake than others. This constraint is important – it will be very difficult for the city to implement solutions that are not accepted by those most impacted.
- *Plans must be affordable*. The city's Stormwater Utility has a finite amount of funds available. Currently, they have approximately $15 million per year to invest in stormwater projects <u>citywide</u>. Plans must be formulated that are affordable based upon realistic expectations of affordability.
- *Plans must provide an appropriate level of economic value.* The cost of solutions must be in line with the cost of flooding. As previously indicated, the net present value of flooding the watershed is $XXX. Therefore, the maximum cost of any project should generally be in line with this amount.

A simplified view of these objectives and constraints is illustrated in Figure 5. The recommended plan must find the optimum balance of effectiveness, affordability, and acceptability. In many instances, it is quite easy to identify plans that meet just two of these, but consideration of the third creates a tension.

Figure 5
Competing Objectives



In the original study conducted by Freese and Nichols, they were directed to only consider alternative that provided solutions to flooding up to and including the 100-year event. Such an absolute requirement does not recognize aspects related to affordability and acceptability, and therefore the identified plans did not pursue the proper balance of these competing objectives.

5.3 Identification and Screening of Measures. An initial list of measures were identified, and are listed below. Measures in italics were eliminated during screening process:

- *Mandatory acquisition of flood prone residential property*
- *Mandatory acquisition of flood prone residential property and construction of detention basins*
- *Mandatory acquisition of flood prone residential property and construction of detention basins; abandon portion of street and replace with turn-arounds or cul-de-sacs, and include abandoned street in detention area*
- Voluntary acquisition of flood prone property
- *Bio-retention (rain gardens)*
- *Rain barrels*
- *Impervious pavements*
- *French drains in alleys*
- *Detention basin in commercial areas, including CVS*
- Detention basin near intersection of Hulen and Bryce
- Underground detention at Stripling Middle School
- Underground detention at Stripling Middle School with diversion along Bryce
- Underground detention at South Hi Mount Middle School
- Underground detention at South Hi Mount Middle School with diversion from El Campo
- Underground detention below city streets
- *Underground detention in alleys*
- 100-year tunnel to Clear Fork of Trinity River
- 5-year tunnel to Clear Fork of Trinity River
- *Backdrain to Trinity River to north*

- *Mandatory acquisition and re-establishment of existing stream*

5.4 Alternatives. A number of alternative plans were formulated. These plans are described in the following section. The description includes an evaluation of each alternative plan in terms of its effectiveness, its affordability, and its acceptability. As a benchmark for comparison, the best alternative from the previous Freese and Nichols study is included as Alternative 1.

Alternative 1 – Selective Buyout (see VE Alternative No. 5)

Description – This alternative includes the construction of a new storm sewer system to replace the existing system. The pipes are sized to carry the 100-year event, and will be constructed by a mostly open cut trench. The alternative will require the acquisition of four homes in the alignment of the storm sewer (thus the title of the alternative, which is otherwise misleading). Figure 6 illustrates this alternative.

Effectiveness – This alternative is highly effective in addressing flooding in the Central Arlington Heights watershed, as it would eliminate flooding from events expected to occur, on average, once every 100-years. This would add increase the level of service by 2.8 inches of rainfall, from 1.0 inches to 3.8 inches. However, the plan calls for an outfall at the same location as the existing system, and the resultant peak flow in the outfall channel would be sufficiently larger than the current peak flow. At present, there is not adequate capacity to convey the existing discharge, as it mostly sheet flows over the Union Pacific Rail Yard.

Affordability – This estimated cost for Alternative 1 is $26,700,000. Additional costs would be incurred to mitigate impacts at the outfall. The high cost of the alternative would require phasing, and benefits in the most floodprone area would not be realized until all phases are constructed.

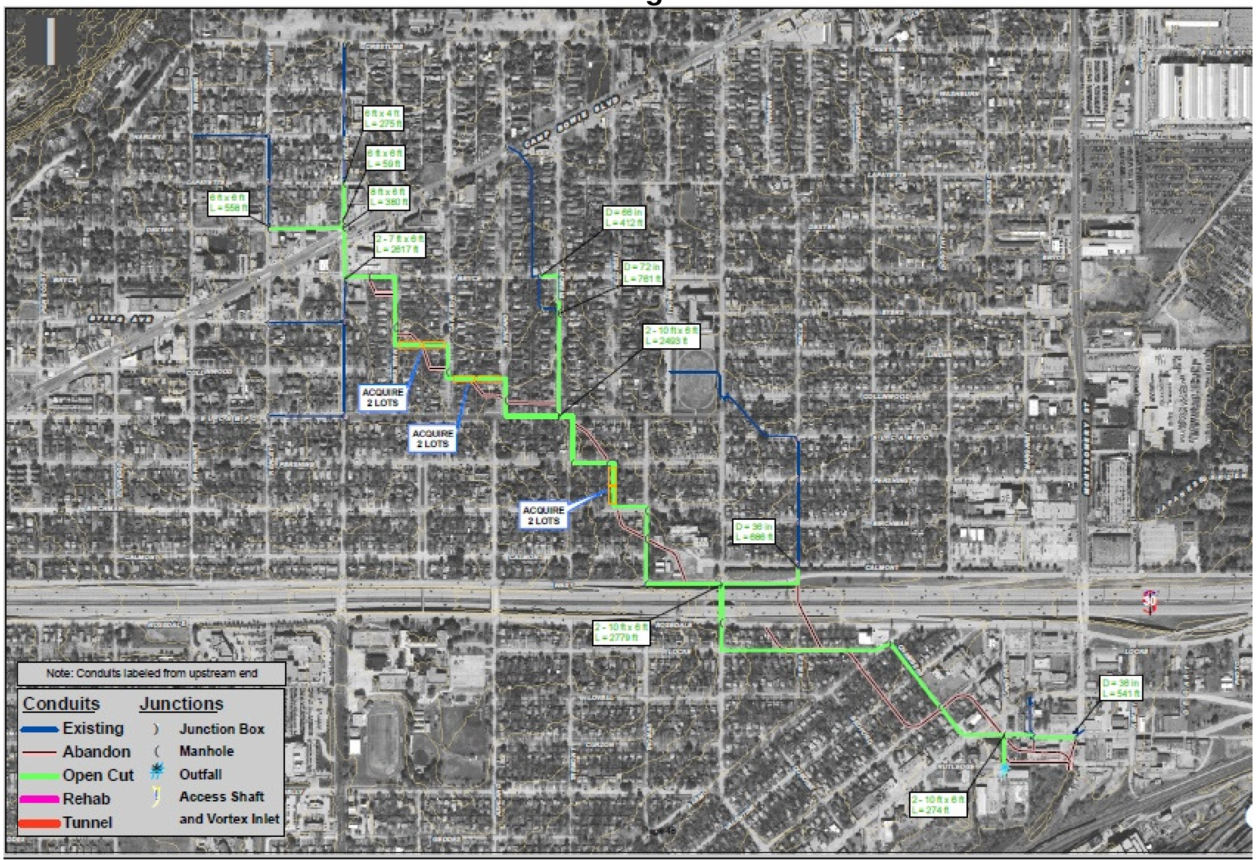
Acceptability – The plan would require the acquisition of four properties, and the stakeholders have expressed strong opposition to acquisition. In addition, the construction of the project would be intrusive, causing access problems. Last, the issues at the rail yard raise significant acceptability question. However, give the strong performance of the plan, it is believed that the community would find it an acceptable alternative.

Alternative 2 – Alternative 1 with 5-Year Level of Service

Description – This alternative is the same as the one presented as Alternative 1, with the exception that the pipes would be sized to provide a level of service for the 5-year event (2.2 inches of rainfall in one hour). Figure 6 also illustrates this alternative.

Effectiveness – This alternative is would be highly effective in addressing flooding from more common rainfall events. For larger and less frequent rainfalls, there would still be some residual flooding. The alternative would add increase the level of service by 1,2 inches of rainfall, from 1.0 inches to 2.2 inches. As with Alternative 1, the plan calls for an outfall at the same location as the existing system, and the resultant peak flow in the outfall channel would be sufficiently larger than the current peak flow. However, it would be sufficiently less than in Alternative 1. At present, there is not adequate capacity to convey the existing discharge, as it mostly sheet flows over the Union Pacific Rail Yard.

Figure 6
Alternative 1&2
Tunnel Alignment

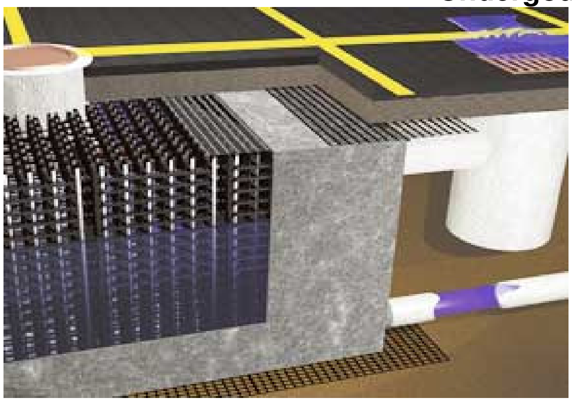


Acceptability – The plan would require the acquisition of four properties, and the stakeholders have expressed strong opposition to acquisition. In addition, the construction of the project would be intrusive, causing access problems. Last, the issues at the rail yard raise significant acceptability question. Based on information obtained from the public engagements, this measure is highly acceptable.

Alternative 3 – Underground Storage Units

Description – This alternative involves the installation of underground modular water storage units in public rights-of-way and under parking areas. The modular units are designed to handle some traffic load, although they are not rated for heavy and/or frequent traffic. As such, they could be installed along the edge of road right-of-ways, and this installation would occur in concert with regularly scheduled road repaving projects. As opportunities present themselves, they could be installed in alleys and under parking lots. The installation under parking lots would involve the city acquiring an easement from the owner of the property, or the city providing incentives to encourage private interests in installing the units. The units would be designed to gravity drain into drainage pipes, so they would best function near existing storm sewer pipes. The evaluation of this measure assumes sufficient installations to store the equivalent of one-half inch of excess runoff. Figure 7 illustrates this alternative.

Figure 7
Alternative 3
Undergound Storage Units



Effectiveness – The effectiveness of this measure depends on the amount of storage provided. Since the installations would mostly occur in concert with scheduled repaving projects, the installation of the storage modules would occur incrementally over time. It is estimated that it would take approximately 20 years to obtain sufficient volume to increase the level of service by 0.5 inches of runoff, from 1.0 inches to 1.5 inches.
Affordability – The estimated cost of this alternative is $9 million. Underground detention is typically several times more expensive then surface detention. Some cost savings is realized by installing the modules in concert with street repaving projects. In addition, the underground units invoke a higher maintenance cost than surface detention basins.

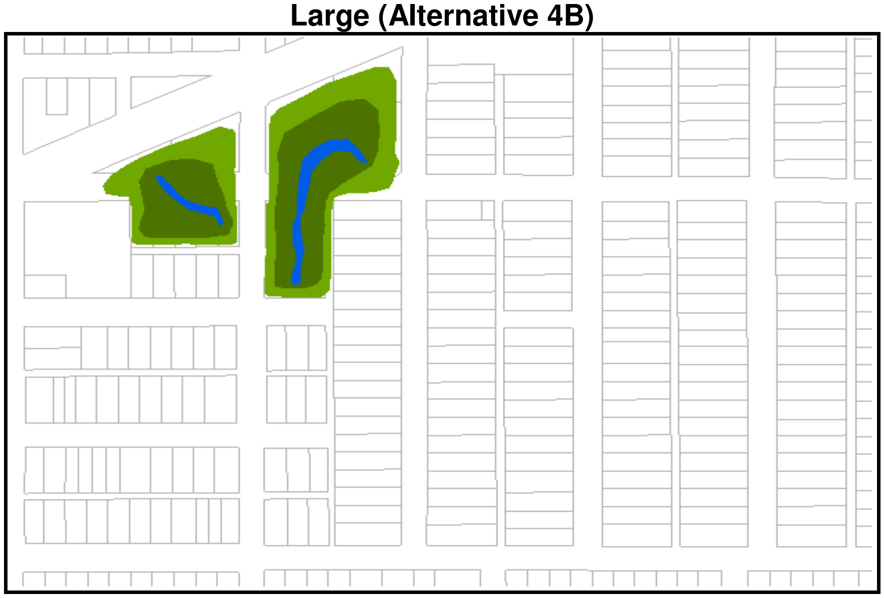
Acceptability – The underground units are underground and hidden, and will not impact the look of the community. Based on information obtained from the public engagements, this measure is highly acceptable.

Alternative 4 – Non-Residential Detention

Description – This alternative involves the acquisition of commercial and multi-family residential properties near the intersection of Hulen Street and Bryce Avenue for the purpose of construction a surface detention basin. This basin would intercept runoff draining toward the low areas of Carleton Street and Western Avenue. Elevation wise, the land is not located in a low area, and therefore no flood storage would be realized at the higher elevations within the basin. Inflow structures would be designed to prevent flow into the basin until a near flood threshold is obtained. Underground pipes would be required to connect the basins to existing underground storm sewers. The detention area would be landscaped and amenitized in a manner for it to act as community asset. Two configurations were considered – a small version and a large version. Figure 8 illustrates this option.

Figure 8
Alternative 4
Small (Alternative 4A)
Non Residential Detention

Large (Alternative 4B)



Effectiveness – The small version would increase the level of service by 0.3 inches of runoff, from 1.0 inches to 1.3 inches. The large version would increase the level of service by 0.8 inches, from 1.0 inches to 1.8 inches.

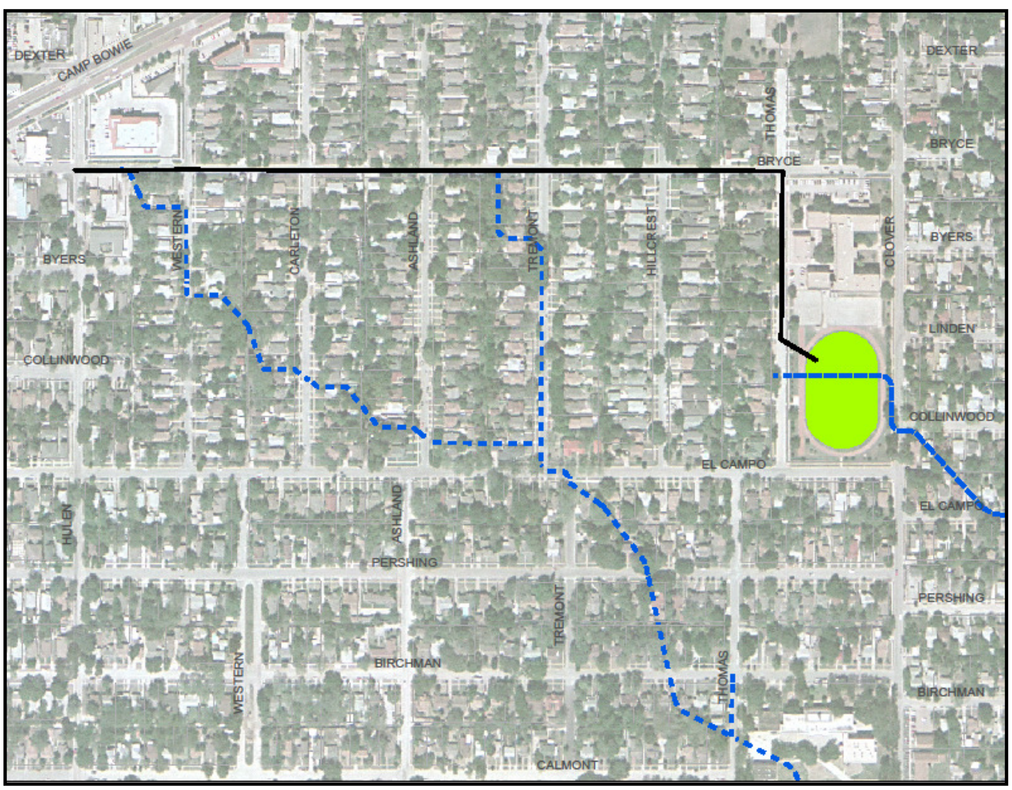
Affordability – It is estimated that the small version of this alternative would cost $3.3 million, while the larger version of this alternative would cost $12.4 million.

Acceptability – Based on information obtained from the public engagements, this measure is highly acceptable.

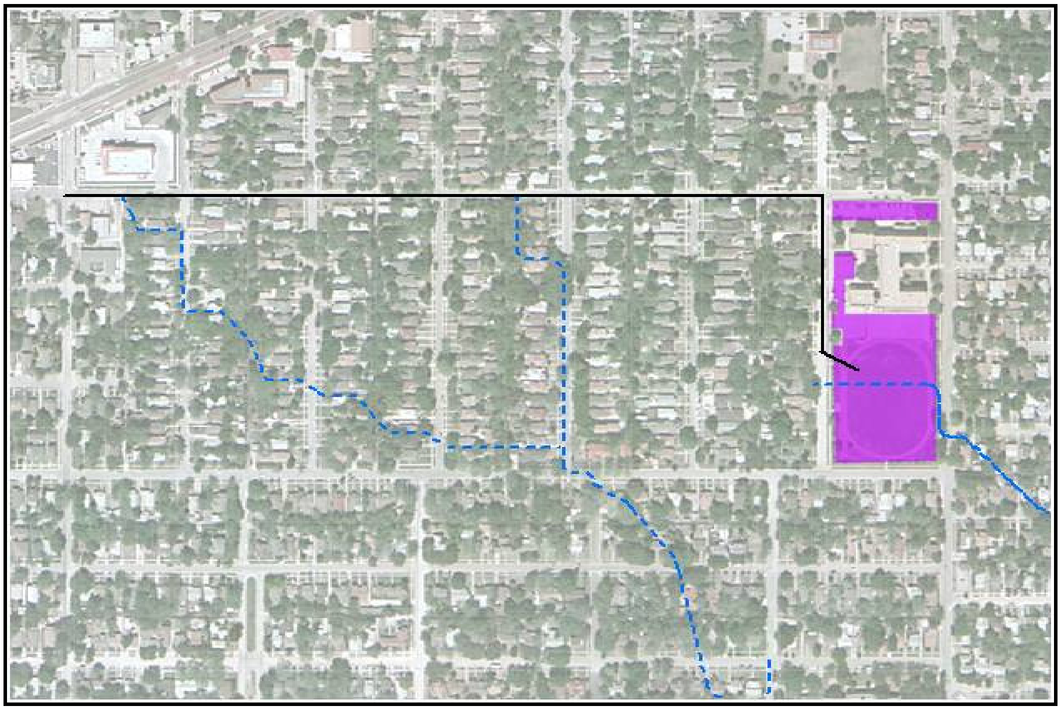
Alternative 5 – Stripling Detention

Description – This alternative involves the utilization the campus of Stripling Middle School to provide detention storage. Two versions of this were considered – one that involves excavating the lands inside the running track in order to obtain surface detention, and another that involved the installation of underground storage units below the playing fields and perhaps even the parking lot. The campus is located in a different sub-drainage system than the most floodprone areas, and has minimal contributing drainage area. In order for this alternative to provide a solution, excess runoff would be diverted from the area near the intersection of Hulen Street and Bryce Aveneue via a new storm sewer pipe in the Bryce Avenue right-of-way. This would require some substantially deep storm sewer installations, likely involving tunneling, due to the topographic variability in Bryce Avenue. The basin would gravity outfall to the existing storm sewer system that drains toward Hi Mount. For the surface detention option, the field would be lowered inside the track by approximately eight feet, allowing for continued use and for spectator viewing on the side slopes. Figure 9 illustrates this option.

Figure 9
Alternative 5
Surface Version (Alternative 5A)
Bryce Diversion to Stripling Middle School



Underground (Alternative 5B)



Effectiveness – The surface detention version would increase the level of service by 0.5 inches of runoff, from 1.0 inches to 1.5 inches. The underground storage version would increase the level of service by 1.1 inches, from 1.0 inches to 2.1 inches.

Affordability – It is estimated that the surface detention version would cost $6.2 million. It is estimated that the underground detention version would cost $16.2 million.

Acceptability – Based on information obtained from the public engagements, this measure is highly acceptable. However, the school district must agree to this option, as it requires utilization of its lands.

Alternative 6 – South Hi Mount Detention

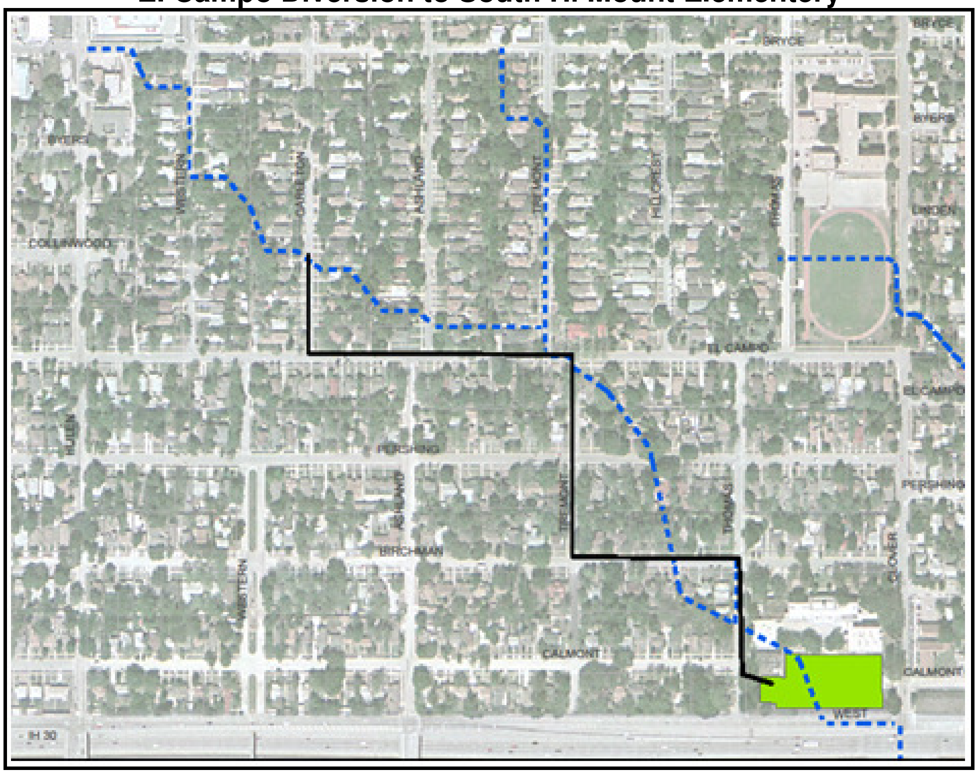
Description – This alternative involves the installation of underground detention on the campus of South Hi Mount Elementary School. The underground detention would be gravity drained to the existing storm sewer system. In order to provide relief to the most flood prone areas, an additional storm sewer line would be constructed from Carleton Avenue and along portions of El Campo A, Tremont Avenue, Birchman Avenue, and Thomas Place to the detention storage on the South Hi Mount campus. Figure 10 illustrates this option.

Effectiveness – The alternative would increase the level of service by 0.3 inches of runoff, from 1.0 inches to 1.3 inches.

Affordability – It is estimated that this alternative would cost $5.7 million.

Acceptability – Based on information obtained from the public engagements, this measure is highly acceptable. However, the school district must agree to this option, as it requires utilization of its lands.

Figure 10
Alternative 6
El Campo Diversion to South Hi Mount Elementery

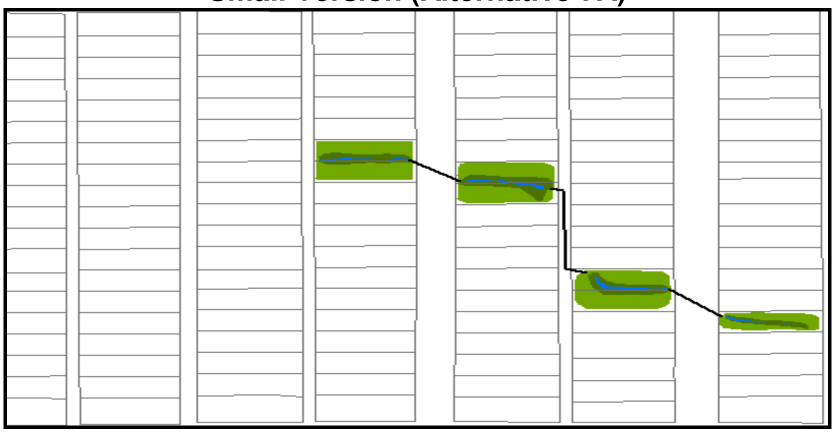


Alternative 7 – Greenway Detention

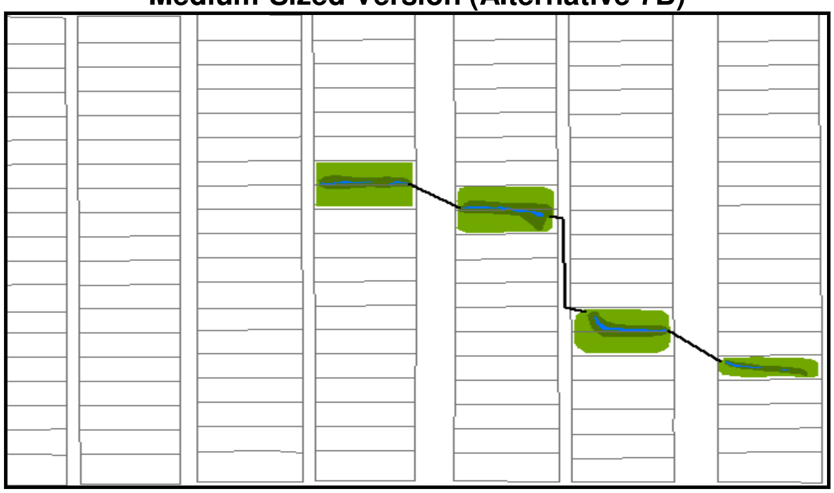
Description – This alternative calls for the establishment of surface detention in a greenway located in the lower areas in the upper portion of the watershed. This would require the acquisition and removal of homes that are currently subject to chronic flooding in order to secure lands for the greenway detention. The detention storage area would gravity drain into the existing storm sewer system. The detention area would be landscaped and amenitized in a manner for it to act as community asset. Three configurations were considered – a small version, a medium sized version, and a large version. It is estimated that the small version would involve the acquisition of approximately 7 homes, while the medium sized version would require the acquisition of approximately 15 homes and the larger version would require the acquisition of 30 homes, 2 commercial tracts, and a multi-family residential complex. Figure 11 illustrates this option.

Effectiveness – The small version would increase the level of service by 0.3 inches of runoff, from 1.0 inches to 1.3 inches. The medium sized version would increase the level of service by 1.2 inches, from 1.0 inches to 2.2 inches. The large version would increase the level of service by 2.9 inches, from 1.0 inches to 2.9 inches.

Figure 11
Greenway Detention
Alternative 7
Small Version (Alternative 7A)



Medium-Sized Version (Alternative 7B)



Large Version (Alternative 7C)

Affordability – It is estimated that the small version of this alternative would cost $2.4 million, while the medium sized version will cost $5.8 million and the large version will cost $13.4 million.

Acceptability – Based on information obtained from the public engagements, this measure is not acceptable. Most stakeholders had strong objectives to acquisition and removal of homes. Among those subject to chronic flooding, there are residents and property owners who both favor and oppose this alternative.

Alternative 8 – Voluntary Acquisition of Flood Prone Homes

Description – This alternative calls for the acquisition and removal of flood prone homes in situations where the property owner offers the property to the city. The city would develop and implement measures to address the maintenance of the residual property in a manner satisfactory to the community.

Effectiveness – This measure will not increase the level of service of the drainage system. It only serves to eliminate chronic flooding for a particular property, and is 100% effective in reducing flood risk for acquired properties.

Affordability – The cost of this measure depends upon number of volunteers participating. There are 58 homes subject to flooding from the events up to and including the 100-year event. The appraised value of these homes totals about $8.7 million. If every one of these property owners volunteered for acquisition, the total cost of the acquisition is estimated to cost about $13 million (determined by increasing the appraised amount by 50% to account for variation in appraisals, relocation costs, and administrative costs).

Acceptability – Based on information obtained from the public engagements, this measure is not acceptable. Most stakeholders had strong objectives to acquisition and removal of homes. Among those subject to chronic flooding, there are residents and property owners who both favor and oppose this alternative.

Alternative 9 – Do-Nothing (Coping)

Description – This alternative calls for the abandonment of capital plans to address flooding in the Central Arlington Heights watershed, resulting in the utilization of only coping measures to live with the chronic flooding. This alternative is not being pursued by the city, but it is a possible outcome should it become impossible to identify a solution that is effective, affordable, and acceptable. Residents would be left to consider on-site improvements to provide protection, such as floodwalls. Flood insurance would be a means for them to mitigate the cost of the flooding.

Effectiveness – This measure, by definition, would not be effective.

Affordability – There would be no cost to the city beyond the regular maintenance of the existing system. There could be costs to residents in the form of flood insurance premiums, damages from flooding, and on-site measures.

Acceptability – Based on information obtained from the public engagements, this measure is generally not acceptable by many in the community. It should be noted, however, that some residents that are in floodprone homes have voiced that this alternative is a preferable outcome to a plan that involves acquisitions. Since this alternative would be voluntary, it would, by definition, be acceptable to the affected property owner. Weighting this against the general consensus of the neighborhood is difficult, and the acceptability of this alternative is considered neutral.

5.6 Analysis of Alternatives

The previous section identified alternatives and presented an evaluation of them with respect to their overall effectiveness, affordability, and acceptability. In further analysis, each of these attributes was given a score between -5 and +5 for each particular alternative. The scoring is for each attribute is described below:

Effectiveness – Each alternative was graded on its effectiveness in reducing flood damages. An alternative that protects from events up to and including the 100-year event was scored a +5. An event that does not positively reduced flooding was scored a -0-. A negative rating would indicate that the measure increased flood risk. None of the alternatives were given a negative rating.

Affordability – Each alternative was graded on its affordability. Essentially, the estimated cost was prorated on the -5 to +5 scale in a manner that a score of -0- would represent a cost that it is neutral given the city's capacity to fund the project. The rating also considers the "phasability" of the measure – meaning project elements can be constructed in phases in a manner the allows the incremental realization of project benefits.

Acceptability – Each alternative was graded on its acceptability as determined in the public process. The evaluation is based upon general input and feedback, including the responses received in the last public meeting.

Figure 12 illustrates the resultant grading for each alternative. At first glance, it is easy to identify alternatives where one of the attributes grades into the negative, causing that feasibility of those particular alternatives to be questioned. Alternatives 1 and 2 can be eliminated due to lack of affordability, and Alternatives 7B and 7C are not feasible. Since Alternative 9 is a do-nothing alternative, the feasibility of this not under consideration.

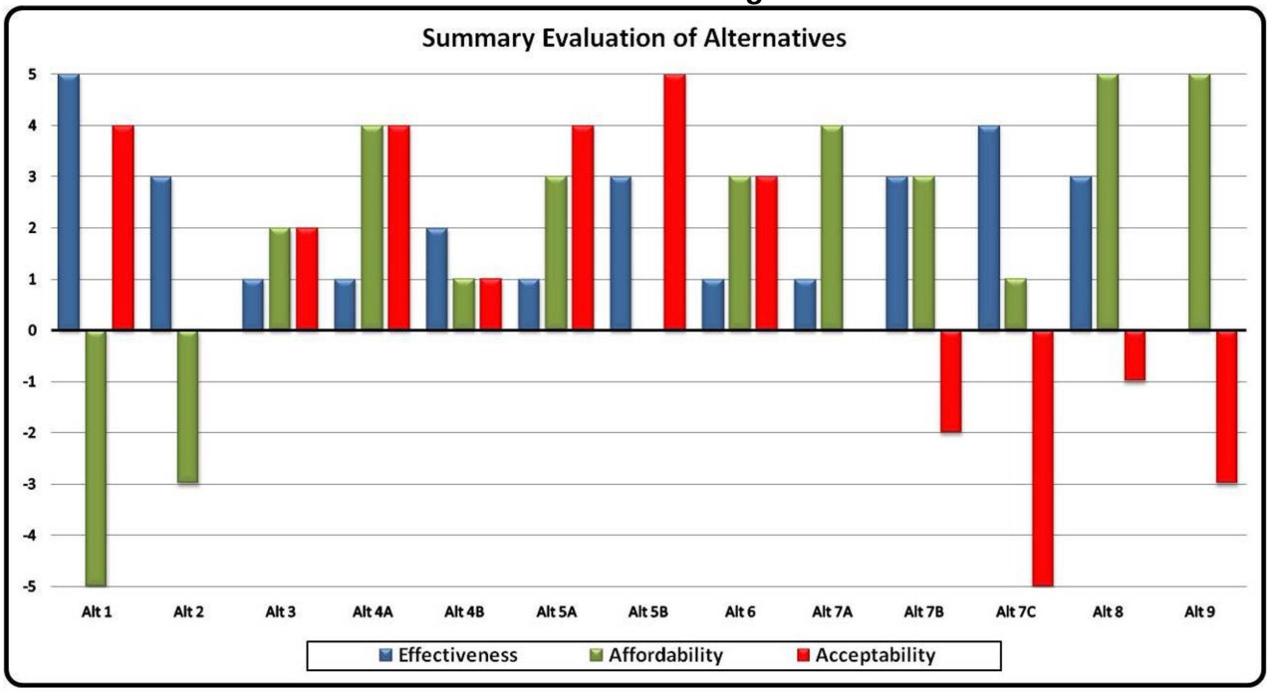
The following summarizes the evaluation of each alternative, with some general commentary summarizing the evaluation:

Alternative 1 - Selective Buyout (see VE Alternative No. 5) – Not feasible due to lack of affordability.

Alternative 2 – Alternative 1 with 5-Year Level of Service - Not feasible due to lack of affordability.

Alternative 3 – Underground Storage Units - Feasible, but lacks effectiveness. Some marginal benefits could be obtained by implementing on a programmatic basis, but will not deliver near term and substantial solutions to flooding.

Figure 12
Alternative Grading



<u>Alternative 4 – Non-Residential Detention</u> – The smaller version (4A) is not very effective, but could be implemented in a fairly straightforward manner. The larger version (4B) has some small benefits, and is marginally affordable and acceptable. The smaller version considers properties that would be rather inexpensive to acquire where there may be an interest by the seller. To get real effectiveness, a larger detention basin is desired, as there is an economy of scale. Further analysis at a greater detail would flush out the concept, and could also include an optimization of the alternative. It is anticipated that some middle ground between 4A and 4B may produced a more robust alternative. In terms of effectiveness, this alternative only provides relief from flood flows draining from the north, and therefore would be limited in its overall impact.

<u>Alternative 5 – Stripling Detention</u> – The surface detention version (5A) is not very effective, but is affordable and acceptable. The underground detention version (5B) is effective and very acceptable, but there are questions of affordability. Further analysis could result in some optimization, perhaps with a combination of surface detention and underground detention; or, if surface detention is not compatible with the school's use, then a smaller version of 5B could be identified that reduces costs. There is a lot of unknown regarding the construction of the diversion pipe down Bryce Ave., especially related to the change in topography along this route. Figure 13 shows a photograph looking down Bryce Ave. that illustrates the challenges with taking a pipe down that route. This plan relies on the ability to construct detention storage measures on Fort Worth Independent School District property, and it is therefore imperative that they endorse and approve this plan.

Figure 13
Bryce Ave. – Route of Stripling Detention Diversion Storm Sewer
(Pipe would have to flow "downhill" from this point)

Alternative 6 – South Hi Mount Detention – The alternative is not very effective, as there is minimal storage availability on the campus. It does grade well in affordability and acceptability, and is worth consideration if it could be combined with other alternatives. As with Alternative 5, there is concern regarding the construction of the pipe that diverts flow to the detention basin, but it does not have the topographic challenges that Alternative 6 incurs. This plan relies on the ability to construct detention storage measures on Fort Worth Independent School District property, and it is therefore imperative that they endorse and approve this plan.

Alternative 7 – Greenway Detention – The smaller version of this alternative (7A) does not provide all that much benefit beyond the elimination of flood risk to the acquired properties. However, the middle size (7B) and larger (7C) versions of this alternative are extremely effective. The alternatives are all affordable, and the middle size version is very affordable. Looking at effectiveness and affordability (essentially, a benefit-to-cost evaluation), some permutation of Alternative 7 (most likely something close to the middle sized version) is by far the most effective alternative. However, the notion of acquisition of homes within the community is extremely unpopular, and the opposition increases with the size of the plan.

Alternative 8 – Voluntary Acquisition of Flood Prone Homes – It is difficult to make comparable gradings of this alternative, as it only involves benefits to individual properties. If no feasible structural project is identified and implemented to reduce chronic flooding in the Central Arlington Heights watershed, then this is the only technique remaining to provide relief to those homeowners and residents who are subject to frequent flooding.

Alternative 9 – Do-Nothing (Coping) – As mentioned earlier, this is not a true alternative solution to flooding. It is, however, the end result if feasible plans are not identified and implemented.

5.7 Recommendations. There are a number of alternatives presented that, by themselves, will not make a large positive impact on flood risk in the Central Arlington Heights watershed. However, these alternatives could be combined with other alternatives in order to pursue a higher level of effectiveness. The South Hi Mount Elementary detention alternative pairs well with the Stripling Junior High alternative, and a plan that combines these two could be very effective. This was by far the most popular alternative when presented to the public.

Another popular alternative involves the acquisition of commercial properties near the intersection of Hulen Avenue and Bryce Avenue. There are some properties for sale or otherwise easy to acquire in this vicinity, but to be effective this alternative requires the acquisition of additional property. To avoid residential acquisitions, this alternative would require the acquisition of commercial property along Camp Bowie, which are substantially more expensive.

The construction of detention in the low areas, also known as Greenway Detention, requires the acquisition of flood prone property along Western Avenue, Carleton Street, and Ashland Avenue. This is by far the most effective and affordable, and also by far the least acceptable. For the most part, effectiveness and affordability are static over time; while acceptability can be variable. Based upon feedback received in the public process, Greenway Detention is not a feasible option. However, in the event that publics sentiment changes (perhaps due to one or more flood events), this alternative warrants further study – but not implementation.

The installation of underground storage modules as city streets are reconstructed will not provide a near term solution to flood risk. However, it is a good long term practice to reduce flood damage and increase storage capacity in the watershed. In addition, tShe acquisition of floodprone property when homeowners approach the city is a straightforward way to reduce damages.

Based upon the study of flooding in the Central Arlington Heights watershed, the following alternatives are recommended for near-term implementation:

- Install underground detention modules in Western Avenue right-of-way in conjunction with scheduled street re-construction project.
- Install underground detention modules in Ashland Avenue right-of-way in conjunction with scheduled water and sewer project.Acquire available properties near Hulen Street and Bryce Avenue and install interim detention storage.
- Acquire flood prone residences on a voluntary basis, and develop and implement secondary use plan.

In addition, the following alternative are recommended for implementation as schedules and coordination with others facilitates:

- Acquire land and construct surface detention basins near Bryce Avenue and Hulen Street.
- Install underground detention modules in city rights-of-way in conjunction with street re-construction projects.

- Install underground detention at Stripling Middle School and South Hi Mount Elementary schools.

Lastly, the following alternative requires additional feasibility analysis, and should be implemented if determined to be feasible and as funding allows (could be a considerable time, depending on cost):

- Divert Flow to FWISD Detention Sites